Pipelines as Networked Communication Links

Kelvin T. Erickson, E. Keith Stanek, C. H. Wu
Ann Miller, and Shari Dunn-Norman
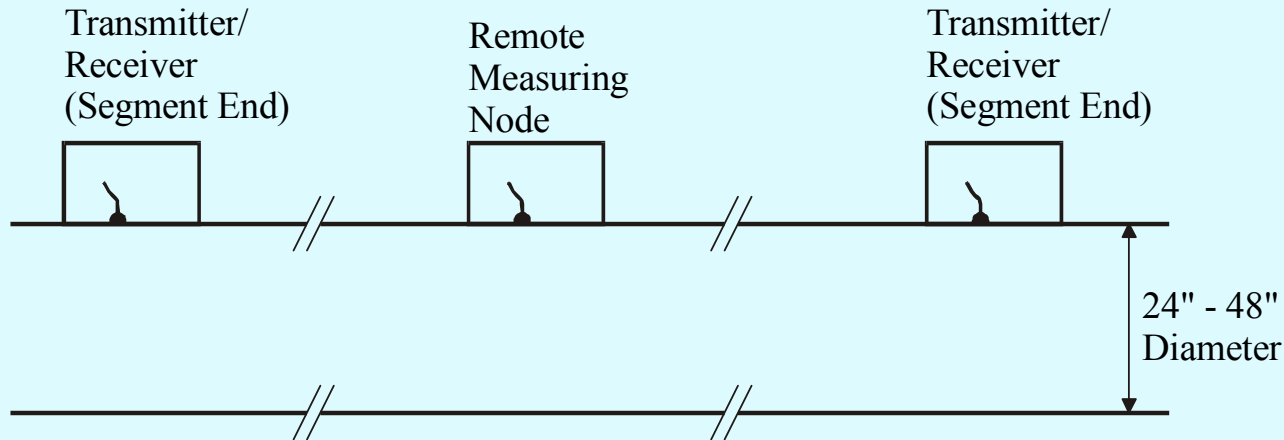
Pipeline as Communication Link

Why?

- GASNET communications net
- Pipe Explorer autonomous vehicle
- Communication link with smart pigs
- Power to remote sensors
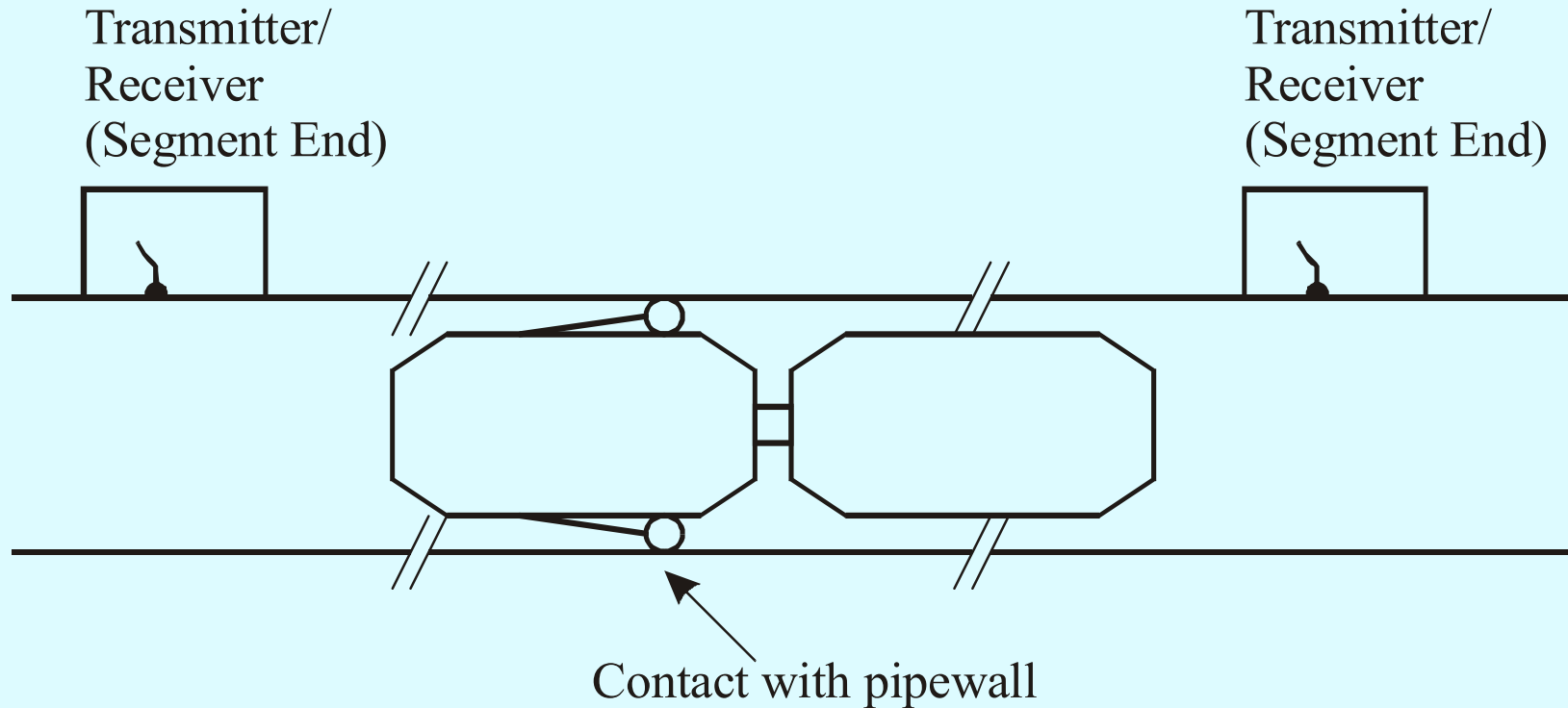- Secure communications

Outline

- Pipeline as leaky feeder
  - Test on actual pipeline
- Pipeline as waveguide
  - Test feasibility on UMR flow loop
- Communication protocol

Pipeline as Leaky Feeder

Transmitter/
Receiver
(Segment End)

Remote
Measuring
Node

Transmitter/
Receiver
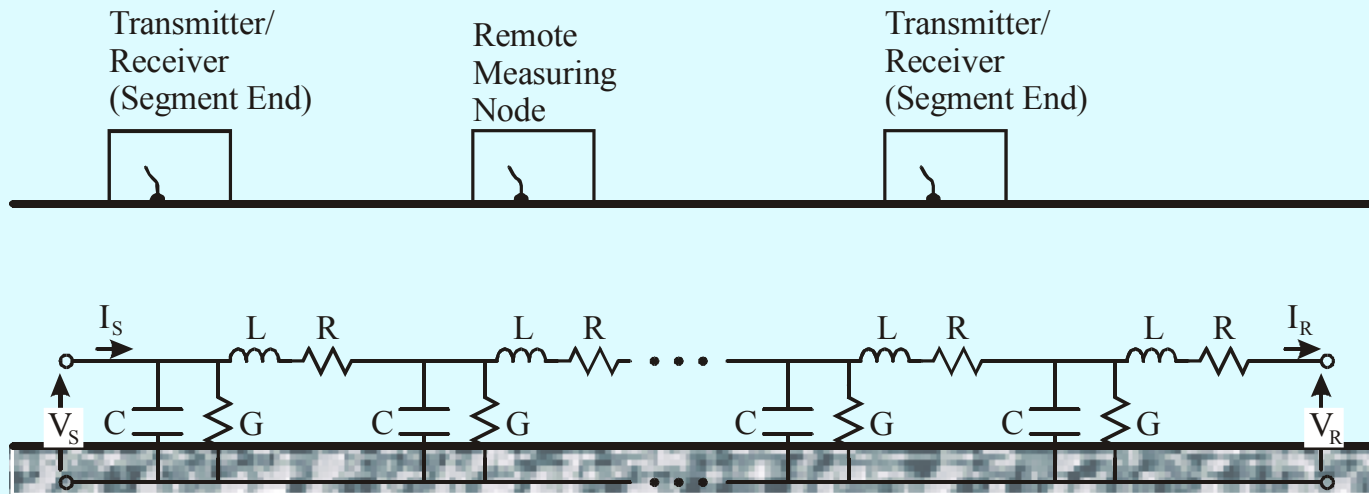(Segment End)

24" - 48"
Diameter

- AC signal injected into pipe
- Analogous to multi-grounded neutral in power systems (remote meter-reading)
- Segments delineated by insulator (flange joint)
- No pipe tapping for installation/repair

Communication with Pipe Explorer

Transmitter/
Receiver
(Segment End)

Transmitter/
Receiver
(Segment End)

Contact with pipewall

- Some contact with pipe

Model of Pipeline

Transmitter/
Receiver
(Segment End)

Remote
Measuring
Node

Transmitter/
Receiver
(Segment End)

I_S L   R   L   R   · · ·   L   R   L   R I_R
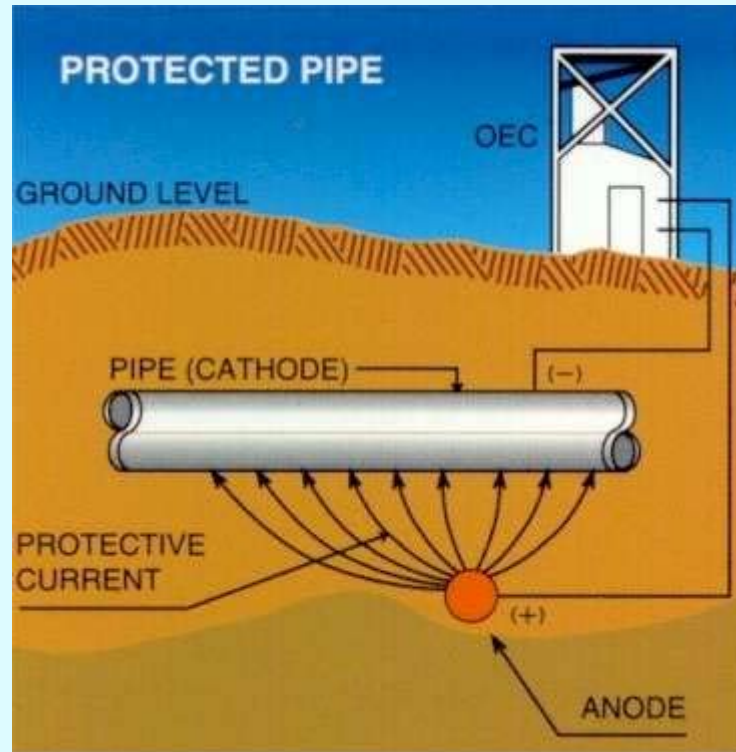
V_S C   G   C   G   C   G   C   G V_R

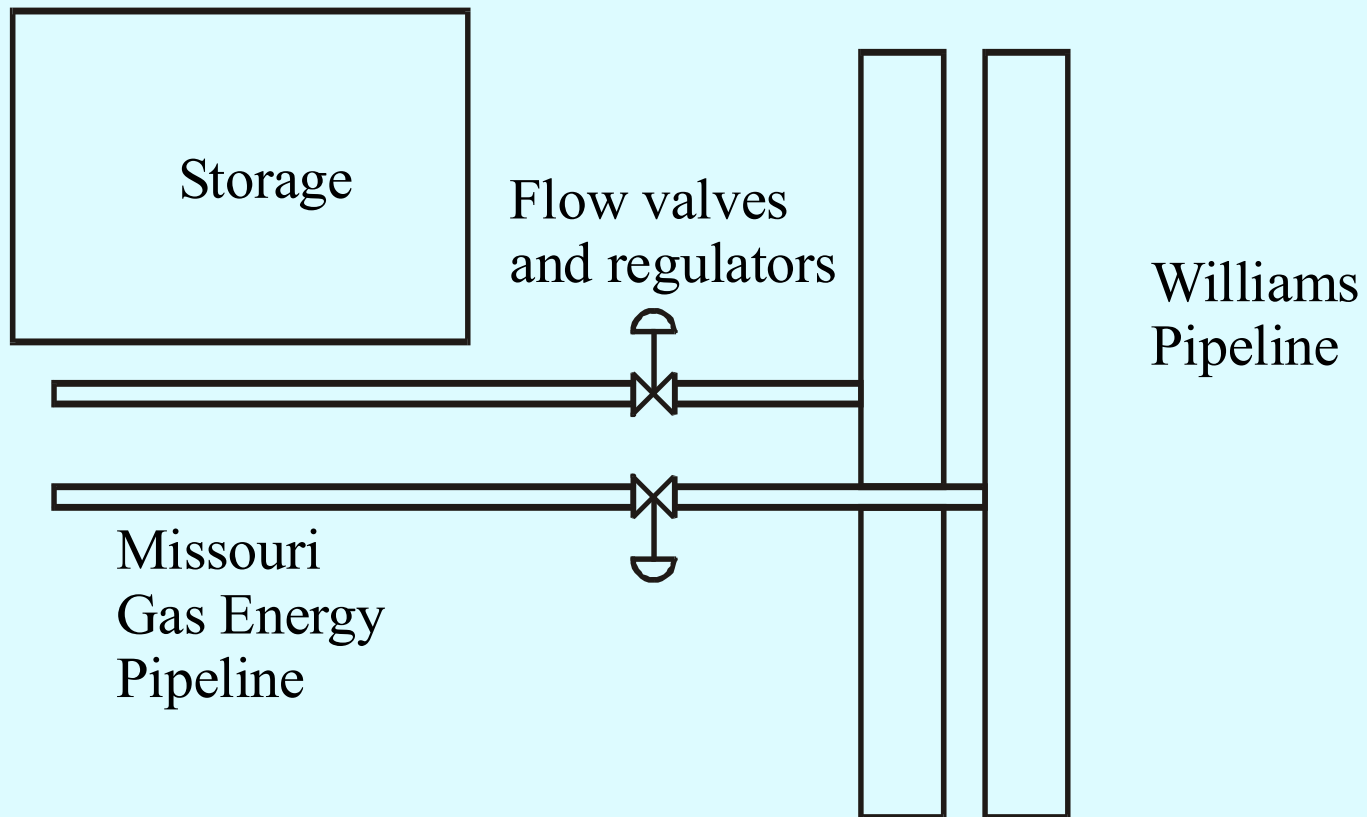- Need to find effective R, G, L, C

Design Considerations

- Effect of flexible connections
- Effect of corrosion
- Integration with cathodic protection
- Use in plastic pipe
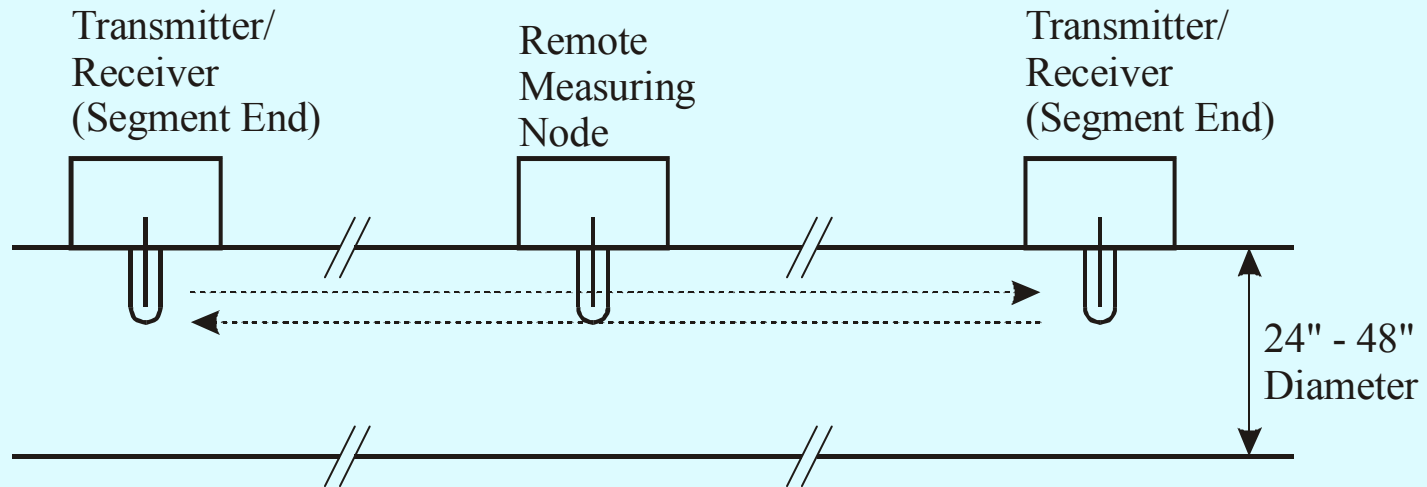- Effect of pipe break
- Power needed

Cathodic Protection

Tests at Missouri Gas Energy

Storage

Flow valves
and regulators

Williams
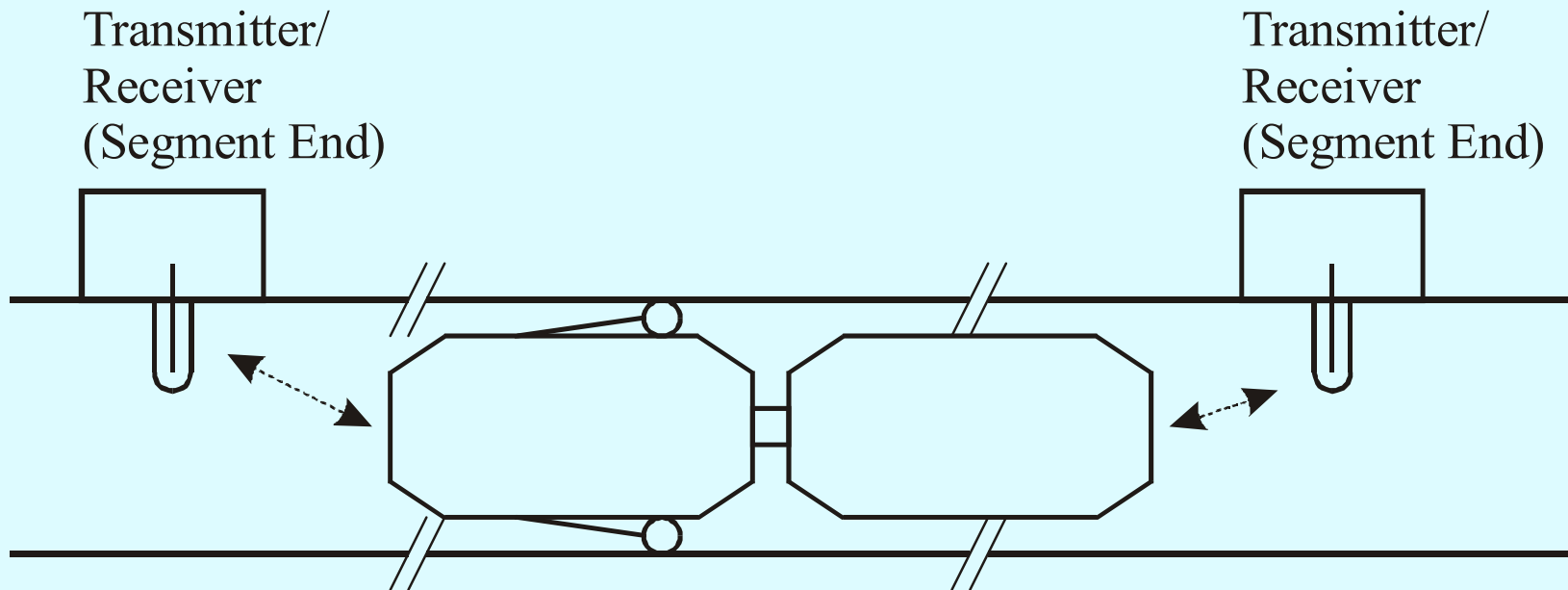Pipeline

Missouri
Gas Energy
Pipeline

Pipeline as Waveguide

- Radio waveguide (150 MHz – few GHz)
- Segments delineated by obstruction (valve, compressor)
- Intermediate nodes possible
- Hot tap installation/repair

Communication with Pipe Explorer

Transmitter/
Receiver
(Segment End)

Transmitter/
Receiver
(Segment End)

- Contactless

Design Considerations

- Effect of bends, flexible connections
- Effect of corrosion
- Use in plastic pipe
- Effect of pipe break
- Pipe ferromagnetic properties
- Integrate with pigging and cathodic protection

Tests on Flow Loop

University of Missouri-Rolla

Network

Distribution Station –
Multiple Segment
Connections

Compressor
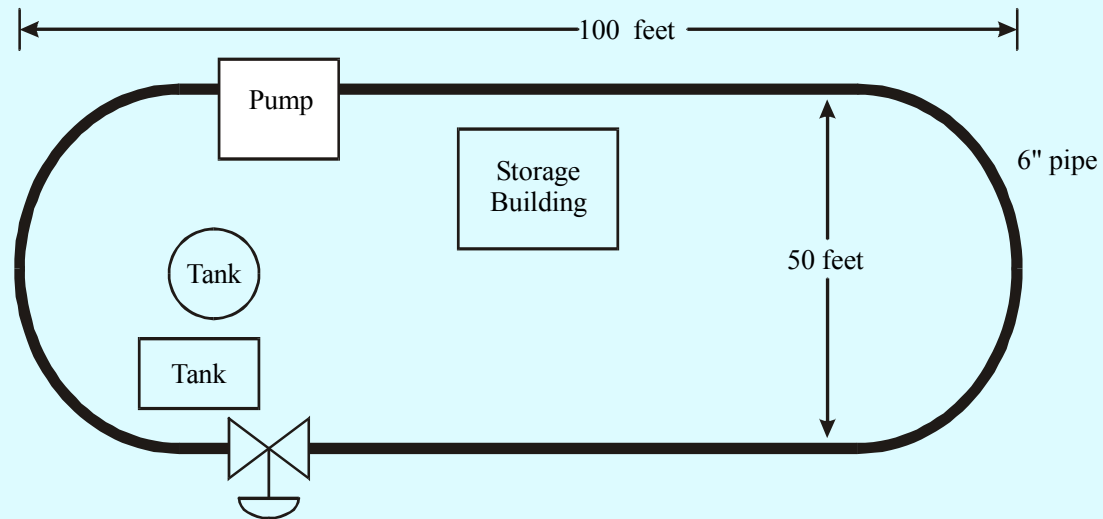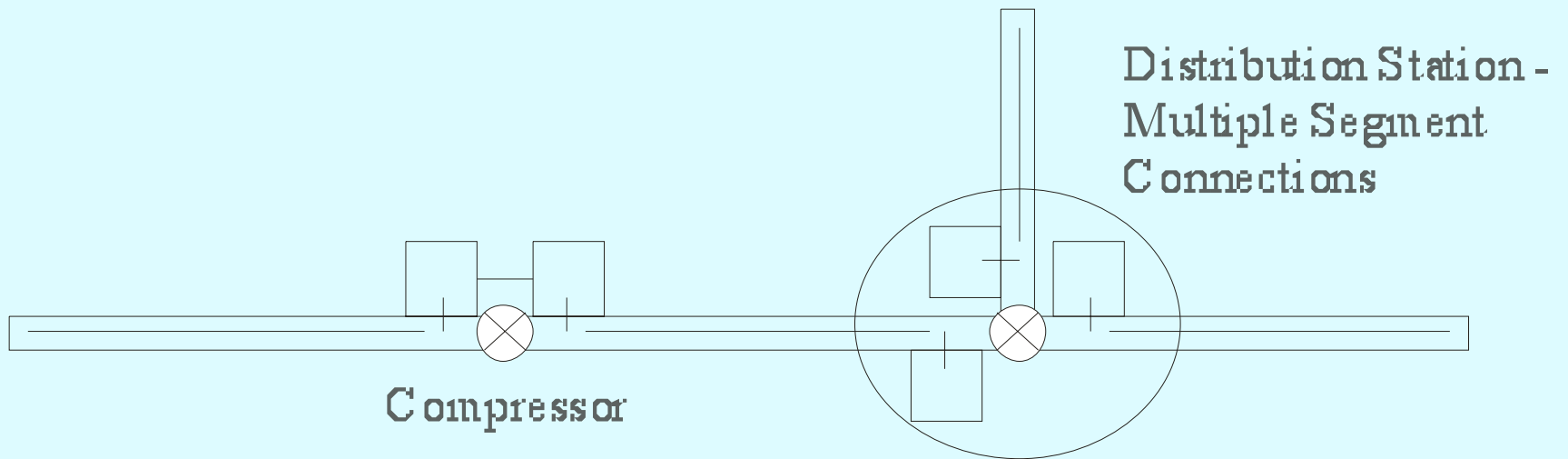
Network Security

- Network health and status monitoring
- Access control
- Remote access monitoring and auditing
- Intrusion detection

Project Progress

- Currently investigating feasibility
  - Direct Signal Injection
  - Waveguide
- Completion date: April 1, 2003